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ENGINEERING AND TECHNICAL SERVICES AS THE ELEVENTH ELEMENT IN INTEGRATED LOGISTICS SUPPORT

by

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Engineering and Technical Services
as the Eleventh Element in
Integrated Logistics Support

by

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ABSTRACT

This thesis identifies and discusses criteria that can be used to determine whether or not an element of logistics is to be used as a stand-alone Integrated Logistics Support element. Six criteria are developed and used to support and analyze the primary question asked in this thesis: Should Engineering and Technical Services be included as the eleventh Integrated Logistics Support element? This analysis concludes that Engineering and Technical Services does meet all of the established criteria requirements and should be included as an additional Integrated Logistics Support element to be used by military and civilian acquisition personnel. This study also recommends actions and areas for further study that will provide insight into improving Engineering and Technical Services support for the future.

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I. INTRODUCTION

A. OBJECTIVE

The objective of this thesis is to examine the possibility of making Engineering and Technical Services (ETS) an eleventh element in Integrated Logistics Support (ILS). There are currently ten ILS elements used in the military acquisition process. None of these logistics elements contain references to ETS. The first step is to define the nature of an element of logistics. Next, a set of criteria identifying a logistics element is developed through extensive research. This definition and set of criteria is used in the next step to determine whether ETS should be considered for establishment as a stand-alone ILS logistic element for use in the Department of Defense (DoD) acquisition system. This thesis provides an accurate and systematic account of the origins of the currently existing ten DoD ILS logistics elements and the purpose each one serves. A detailed account is provided to the reader of the role that ILS elements play in the current weapons system acquisition and life cycle processes and the role ETS plays.

B. RESEARCH QUESTIONS

1. Primary Research Question

Does it make good logistical sense to add ETS as a separate element to the existing ten elements of ILS?

2. Subsidiary Research Questions

What are ETS's and when are they used? What issues will arise if ETS becomes an ILS element? What are be the benefits if ETS becomes a stand-alone ILS element?

C. SCOPE, LIMITATIONS, AND ASSUMPTIONS

Engineering and Technical Services are used by all of the Armed Forces of the United States. They are also used by foreign militaries who have purchased weapon systems under the United States' Foreign Military Sales program. Another name for ETS, more easily recognized throughout the military, is Technical Representative. The slang most frequently associated with technical representatives is "Tech Reps". The civilian world uses ETS under a variety of names. Engineering and Technical Services working in the private sector are commonly referred to by the following names: contractor repairperson, field services or field reps.

This thesis will focus on ETS as they relate to the military, and more specifically, on ETS used by the United States Naval Aviation community. This limitation is set because the author's background is in Naval Aviation maintenance. Each of the armed services has instructions and

directives pertaining to ILS and ETS. There are some slight differences in each service's literature on this subject but all services are required to, and do, follow DoD guidance on these subjects. Focusing on one service will allow for an easier flow of information. This research also falls under the category of "information required" by the author for use at his next assignment, working at the Navy's ETS command headquarters. Most data pertaining to this thesis topic are ten years old or older. This made it difficult at times to find copies of "out-dated" military instructions, since the military has a tendency to destroy cancelled instructions and directives. Another hardship associated with the use of dated material is that, because of the many reorganizations of major commands in the military, the authors of certain documents are impossible to locate.

Current "right sizing" efforts, funding cutbacks by both the military and public sectors, have brought the subject of ETS back into the limelight. This renewed look at the field of ETS should foster a new influx of studies and material pertaining to ETS from both the military and civilian perspective.

D. METHODOLOGY

The majority of the research conducted for this thesis was derived from the relevant literature. This literature deals with logistics from both a military and public sector

perspective. Another valuable source of information on ILS and ETS was obtained from the numerous Department of Defense and service specific instructions and notices that pertain to the weapon systems acquisition process. Most of the older military documents were obtained through painstaking archival research. Another very important source of information was provided through various interviews, in person and by phone, conducted with both military and civilian personnel associated with the varying aspects of ETS and ILS elements. No formal interviewing format was followed. Each interview was adapted and tailored to specific information and topics that were in keeping with the interviewee's expertise. A formal survey was not conducted by the author because a survey of ETS and their use in the military is currently being conducted by the Defense Resources Management Institute (DRMI).

The combination of all the research currently available on the subject of ETS and ILS elements is used to construct the answers to the questions that this thesis sets out to answer.

E. SUMMARY

This chapter defines the research questions that this thesis explores and attempts to answer. The various sources of information pertaining to this subject are at times dated. Many of the instructions and directives are not currently in use by the military. The information on ETS and ILS elements does overflow into use by the private sector and is

documented. Current trends toward reductions in the size of the military and improved cost savings efforts have lead to a resurgence in research into the topic of Engineering and Technical Services and logistics support in both the military and private sectors.

II. BACKGROUND AND LITERATURE REVIEW

A. INTRODUCTION

1. Brief Logistics History

Logistics has been a part of the military since the beginning of time. From the time of the great Roman armies, generals have known that support for the "war machine" is imperative if an army is to be successful. Many people tried to find a word for this support, from the Greek word "logistikos" meaning skilled in calculating to the Latin term "logista" meaning administrator. (Thorpe, 1986, pp.xvii-xviii) The original concept of logistics dealt with the supply lines that kept the forces in "beans and bullets".

Lieutenant Colonel George C. Thorpe is considered the pioneer of logistics as it is known in the military today. During the time of World War I, Thorpe recognized the importance of logistics and said:

> war had become a business in which logistics was a basic and comprehensive element ... yet while strategy and tactics are much talked of ... there has not yet been recognized a science of logistics. (Thorpe, 1986, p.xvii)

Military leaders, prior to that time, did not formally recognize the field of logistics as an aspect of warfare, they just knew that in order to advance and win battles they needed the war fighting supplies to keep up with their advancing forces at the front line.

Logistics has come a long way since the old thoughts of logistics as being just the transportation and supplying of the front lines. It was Lieutenant Colonel Thorpe who gave a broad view of logistics as:

> being an entity comprised of many activities that acted as a whole ... strategy and tactics constituted the conduct of war; logistics provided the means. (Thorpe, 1986, p.xxii)

This started the realization that logistics is a separate element necessary for the running of a nation's war fighting capabilities. There is much history and there are many examples that lead up to the modern concept of logistics that are too numerous to include in this paper.

A common explanation of the modern logistical concept is:

> the field of logistics support is viewed as the composite of all considerations necessary to assure the effective and economical support of a system throughout its programmed life cycle. (Blanchard, 1992, p.11)

The field of logistics is now included in every aspect and phase of weapon systems procurement. Many different instructions and directives pertaining to all matters that deal with the acquisition of weapon systems have been used in military acquisition. This myriad of guidance was often confusing and hard to follow because it was not combined into one document. The current DoD instruction, DoDINST 5000.2 (dated February 1991), has solved this problem. It is titled: Defense Acquisition Management Policies and Procedures and delineates logistics as a function of the total system. This

document defines Integrated Logistics Support as follows:

> A disciplined, unified, and integrated approach to the management and technical activities necessary to integrate support considerations into system and equipment design; develop support requirements that are related consistently to readiness objectives, to design, and to each other; acquire the required support; and provide the required support during the operational phase at minimum cost.

Integrated Logistic Support policy as stated in Part Seven of the DoDINST 5000.2 is as follows:

> An effective integrated logistics support effort shall be established within each program office. Integrated logistics support shall be managed as a disciplined, unified, integrated approach to the management and technical activities necessary to:
> (1) Developing support requirements that are related consistently to readiness objectives, to design, and to each other,
> (2) Effectively integrating support considerations into the system and equipment design,
> (3) Identifying the most cost-effective approach to supporting the system when it is fielded, and
> (4) Ensuring that the required support structure elements are developed and acquired.

Integrated logistics support efforts shall encompass the ten elements identified in part seven, section A, Attachment one of DoDINST 5000.2. The above quote gives legitimacy to the concept that ILS is part of a system. It also provides direction for the use of Integrated Logistics Support as a requirement in all stages of military systems acquisitions.

2. Integrated Logistics Support Elements

The following is the list of what DoDINST 5000.2 dictates are the ten elements of ILS that "must be addressed for both hardware and software in both peacetime and wartime conditions":

1. Maintenance Planning. The process conducted to evolve and establish maintenance concepts and requirements for the lifetime of the system.

2. Manpower and Personnel. The identification and acquisition of military and civilian personnel with the skills and grades required to operate and support the system over its lifetime at peace and wartime rates.

3. Supply Support. All management actions, procedures, and techniques used to determine requirements to acquire, catalog, receive, store, transfer, issue, and dispose of secondary items. This includes provisioning for both initial support and replenishment supply support and test equipment.

4. Support equipment. All equipment (mobile or fixed) required to support the operation and maintenance of the system. This includes associated multi-use end items, ground handling and maintenance equipment, tools, metrology and calibration equipment, test equipment, and automatic test equipment.

5. Technical Data. Scientific or technical information recorded in any form or medium (such as manuals and drawings). Computer programs and related software are not technical data; documentation of computer programs and related software are. Also excluded are financial data or other information related to contract administration.

6. Training and Training Support. The processes, procedures, techniques, training devices, and equipment used to train civilian and active duty and reserve military personnel to operate and support the system. This includes individual and crew training (both initial and continuation); new equipment training; initial, formal, and on-the-job training; and logistics support planning for training equipment and training device acquisitions and installations.

7. Computer Resources Support. The facilities, hardware, system software, software development and support tools, documentation, and people needed to operate and support embedded computer systems.

8. Facilities. The permanent, semipermanent, or temporary real property assets required to support the system, including conducting studies to define facilities or facility improvements, locations, space needs, utilities, environmental requirements, real estate requirements, and equipment.

9. Packaging, Handling, Storage, and Transportation. The resources, processes, procedures, design considerations, and methods to ensure that all system , equipment, and support items are preserved, packaged, handled, and transported properly, including environmental considerations, equipment preservation requirements for short and long term storage, and transportability.

10 Design Interface. The relationship of logistics related design parameters to readiness and support resource requirements. These logistics related design parameters are expressed in operational terms rather than as inherent values and specifically relate to system readiness objectives and support costs of the system.

It should be noted that ETS is not specifically listed as an element or as being a part of any particular element or elements.

These ten elements are to be used by program managers (PMs) and all other personnel associated with the various phases, planning boards, logistics support analysis (LSA), logistics support analysis record (LSAR) and logistics support plans (LSP) found throughout the acquisition process. The first time these elements are introduced and used in the military acquisition system is in preparation for Milestone I, Concept and Demonstration Approval and the Demonstration and Validation Phase (Phase I). The program manager incorporates the ILS elements into the Operational Requirements Document (ORD) which is based on the Mission Need Statement (MNS) that

is submitted by the requesting service. The ORD is used to develop requests for contract specifications and is continuously updated before each Phase and Milestone throughout the system's life cycle.

3. Engineering and Technical Services

Engineering and Technical Services are defined as:

> Services which provide information, instruction, and training in the installation, operation, modification, and maintenance of aviation systems and equipment used by Department of Defense components. (NAESU, 1989, p.I-1)

These services are provided by qualified DoD military and civilian personnel and contracted employees of private sector companies. This is the definition of ETS used by the Naval Aviation community. It is representative of the definition of ETS used throughout DoD and the private sector.

Engineering and Technical Services formally became a part of Naval Aviation when the Naval Aviation Engineering Services Unit (NAESU) was established in the autumn of 1942. The original name used in 1942 was the Airborne Coordinating Group (ACG). The reason for the creation of NAESU was that the deployment of radar and other "sophisticated" electronic devices had increased the need for highly skilled personnel in the Navy. To fill this need, the Naval Aviation Electronics Service Unit (which would become NAESU in 1959) was tasked with creating a pool of highly trained specialists. These specialists were made available upon request from fleet units. The current mission statement for NAESU is:

> ...to provide field engineering assistance and instruction to Naval Aviation activities in the installation, maintenance, repair, and operation of all types of aviation systems and equipment. (NAESU, 1994)

The Navy breaks down the components that make up ETS into two major categories as listed in the below paragraph. This information is provided in NAESU instruction 5400.1L dated 15 September 1989. It is again stressed that these are the terms used by the Navy; however, the other military services have a comparable structure. The two major components of Navy ETS are the Navy Engineering Technical Services (NETS) and the Contractor Engineering Technical Services (CETS). The military component or NETS is further broken down into two groups. These groups are called: Navy Military Technical Specialists (NMTS) and Navy Civilian Technical Specialists (NCTS). The first group, NMTS, are made up of active duty and reserve military personnel. These sailors possess an in depth knowledge of a particular weapons system or component and act as subject matter experts who fill the role and duties of an ETS member. The NCTS are civilian employees who work for the military as civil servants. They are managed by the Navy and fall under the General Schedule (GS) rating system. They, too, are technical specialists with special qualifications that allow them to provide information, instruction, and training. The CETS side of Naval ETS is also further broken down into two components: Contractor Plant Services (CPS) and Contractor Field Services (CFS). Both of

these types of ETS are provided by the manufacturer of military equipment or components in the initial military weapons system acquisition contract and may be continued after the fielding of the equipment is completed. Plant representatives (CPS's) are located in the plants and facilities of the manufacturer and provide:

> training courses, training-aid programs, system/component knowledge, and other essential skills relating to the development of the technical skills required for installing, maintaining, and operating such equipment. (NAESU, 1989, p.I-1)

The CFS's are contractor personnel located on-site at defense locations. They function as follows:

> CFS personnel provide technical information, liaison as required, and formal, structured, and on-the-job training. They possess specialized knowledge, experience, and skills and have access to information covering the installation, operation, modification, and maintenance of DoD weapons, equipment, and systems. (NAESU, 1989, p.I-1)

The following is a brief description of how ETS are currently being utilized in the military as represented by the Navy ETS system. Further information and description of ETS is provided throughout this paper. Technical services are provided by the contractor or manufacturer as part of the initial system acquisition contract. These services provide for the installation and initial training of Naval personnel in the maintenance and support of the system. The current guidance says that this contracted support is to last for one year after the Navy first receives the system at a Naval location. Contract extensions can be requested if the Navy

cannot organically support the system after one year and needs to continue with contractor support. Once the initial contracted field services have expired, it is up to NAESU in the Navy to provide ETS to the operational units. The operational commands provide the initial input to NAESU as to their expected ETS requirements. NAESU will validate these requirements and apply for appropriate funding and create the necessary contracts. The ETS requirements are validated on an annual basis. This validation includes a cost effectiveness study and updated fleet ETS requirements. The current trend by NAESU is to utilize more NETS than CETS. In 1991, NAESU employed: 316 CETS and 466 NETS. The projected ETS requirements for 1999 are: 183 CETS and 529 NETS. (NAESU, 1993) This trend toward more NETS and less CETS is due to the high cost of using CETS as compared to NETS, private sector civilian pay versus military pay scales, and new developments with regard to the detailing of Naval personnel which will be discussed later in this thesis.

Technical services are not just confined to the military. They are widely used in the civilian sector. Using the above definition of what ETS provide, it is seen that ETS is just another form of Field Representative or Field Service Representative associated with a system or product.

An example will better illustrate the function of ETS in the civilian sector. For example, a large automobile dealership that contains a repair shop utilizes the services

of ETS in much the same fashion as the military. The automobile factory will send a representative to the dealership to train the dealer's mechanics or the dealer may send its mechanics to a factory located school for training. These reps will train the dealer personnel on all facets of the new car or product which is going to be sold. The reps will also be available to the dealership mechanics on an on-site tech assist basis as new problems are found in the new automobile. The factory reps will be able to perform on-site evaluations of the problem for the factory engineers, allowing for smoother customer problem to dealer mechanic to engineer communications. Most of the dealers refer to these tech reps as factory reps. They are an effective interface between the dealer's mechanics and the engineers who built the systems. The factory reps are relied upon by the dealers to keep their mechanics current on the maintenance procedures and systems associated with today's high tech automobiles. These factory reps are considered tech reps as defined by the above paragraphs.

Another form of service provided by field representatives found in both the military and private sector are Contract Maintenance Services (CMS). Contract Maintenance Service is provided by personnel who are not members of the organization which is utilizing the system. These personnel will maintain and operate the system for an organization under a contractual agreement. This type of service is used when it

is not cost effective for an organization to utilize its own personnel to support and maintain a system.

An example of CMS used by the military are the personnel who maintain the F-5 and F-16 aircraft utilized by the Navy's aggressor training squadrons. An example of CMS found in the private sector is the support associated with an organization's copy machine. The most common practice in the public sector is for the office to purchase a maintenance agreement contract or CMS at the same time they buy a complex and expensive piece of equipment like a copy machine. The manufacturer or company that is providing the machine is contracted to provide a person who will install the new copier. This person installs the machine and prepares it for use by the office personnel. This person will also provide instruction and training to the office personnel in the proper usage and routine maintenance (filling with paper, changing the ink and toner, etc.) needed to be performed on the copy machine. This person will also provide the office with a phone number that will allow the office personnel to contact the copier company if a failure or problem with the machine should occur. It is more cost effective for the organization to procure CMS's than to have their personnel provide and store all required parts and to perform all maintenance and support on the copier.

B. SUMMARY

The history behind the field of logistics support is generally related to logistics as used by the different militaries throughout the world. Most of the examples that relate to logistical support deal with the logistics of supplying armies. The current literature and instructions that deal with logistics, view logistics as providing life cycle integrated logistics support for a system.

The history of ETS is not well documented. Engineering and Technical Services from a Naval Aviation standpoint, were started in the autumn of 1942. The original DoD guidance on the elements constituting Integrated Logistical Support of military weapon systems was promulgated in the summer of 1964. The current DoD ILS directive contains ten logistics elements. Engineering and Technical Services are not included as an element or as a part of any existing element. It should also be noted that the current consensus by the drafters of the ten military ILS elements is that the acquisition managers already have enough ILS elements to work with and they do not need a new one. According to the DoD directive, if all of the listed elements are followed and properly applied throughout a system's life cycle there should be no need for the services provided by ETS. (Fink, 1994)

III. METHODOLOGY AND DATA

A multitude of resources was used to research the subject of ILS elements and ETS. A large portion of the research material consists of military directives and instructions. Currently active and many no longer active or cancelled instructions were used. The remainder of the research was conducted through the use of books and interviews. The reason for this research was to find the answer to the question: What is a Logistic Element? The answer to this question allows the author to explore and answer the primary point of this research: Should ETS be an eleventh military logistic element?

There are differing opinions among the various authors of logistic related books as to the number of logistic elements there are or should be. The same is true when it comes to providing names or titles to these elements. Appendices B through E provide examples of different lists of required logistic elements as determined by various authors. It should be noted that the lists are comprised of different elements; however, these elements include basically the same ILS element functions as those currently in use by the military.

On the military side, in 1964, DoD Directive 4100.35 titled "Development of Integrated Logistic Support for Systems and Equipments" for the first time provided military

acquisition personnel with a list of logistic elements that were to be followed and used by the military. These original nine elements are:

1. The Maintenance Plan
2. Support and Test Equipment
3. Supply Support
4. Transportation and Handling
5. Technical Data
6. Facilities
7. Personnel and Training
8. Logistic Support Resource Funds
9. Logistic Support Management Information

The result of various revisions of the DoD acquisition directives and instructions, was that these original nine logistic elements were reworked and another logistic element was added to give military planners the current list of ten logistic elements that is described in Chapter II. These revisions were due to the ever changing policies associated with the military acquisition system. The goal of military planners is to develop an all inclusive, standardized list of ILS elements for use by all of the armed services.

None of the research materials or interviews provided a standard definition of a logistic element. They also did not all agree as to what the exact logistic elements are or what they should be. They did provide enough information that

could be used to formulate a standard "definition" or set of criteria to describe an ILS element.

The criteria listed in the analysis section of this thesis, describe what characteristics are found in an ILS element and were developed using the many references cited. Each reference describes in detail the logistic element it is referring to. This description included what purpose this element serves. It is through these descriptions that a set of criteria for a generic element are formulated. The descriptions of the various logistic elements that each reference referred to are combined to enable the author to formulate specific criterion related to a generic element. These criteria can also be used to compare other future elements to see if they meet the requirements of being a separate ILS element. This comparison is specifically used to take a look at ETS and should enable the author to justify the addition of ETS to the current DoD list of ten ILS elements.

In order to consider ETS as an ILS element, a thorough understanding of what ETS is and what their function is in relation to a weapons system is developed and illustrated. Another way of looking at ETS is to use the definition that Hill (1993, p.247) gives for Field Service. He states that:

> field service is an option for the seller to provide hands-on training and technical support/liaison to customer personnel on the operation and maintenance of the products.

The various research materials pertaining to both the military and private sector use and perceptions of what ETS's mission entails will be used to develop ILS element criteria which in turn will provide a thorough description of ETS as used by Naval Aviation and the private sector.

There is currently a newly formed subgroup of the Aviation Logistics Board in the military called Joint Engineering and Technical Services (JETS). Their mission is to

> provide guidance and recommendations on policy and procedures, requirements, procurement and deployment of ETS throughout DoD. (NAESU, 1994)

One of their priorities is to examine ETS as a stand-alone ILS element. Appendix G provides a brief synopsis of JETS.

IV. ANALYSIS

A. INTRODUCTION

The analysis of this research is broken down into two parts. The first part of this analysis develops a set of criteria or characteristics that can be used to test and define just what a logistic element is. The completion of this part is critical to the analysis found in the second part. The criterion found in part one is used to justify the validity or relevance of using ETS as a stand-alone logistic element.

B. PART ONE

There is no textbook definition that defines what a logistic element is or what components or factors make up an ILS element. Therefore, one must look at the characteristics of each of the current listed elements to search for criteria which could be used to define and justify the existence of a specifically named element. The elements currently used by DoD are used in this analysis. They are looked at using the perspective of a military system's Program Manager. The PM's manage a system throughout its life cycle. They also ensure that all of the ILS elements are incorporated into the system at its very beginning. The word system is used to represent any type of major system being acquired through the

acquisition process by either the military or private sector. A system is defined as:

> a set of objects, together with relationships between the objects and between their attributes, connected or related to each other and to their environment in such a way as to form a whole. (Schoderbek, 1980, p.341)

The other lists of elements found in the appendices support the same findings.

One characteristic common to all of the ILS elements is that they all play an important part in the life cycle of the system. This means that the element is used to support the system throughout its entire life from cradle to grave. The elements are first incorporated into the system at the very beginning of the system's acquisition stage. They are then updated and modified as the system matures. These elements are still utilized even as the system is ending its useful life.

Another characteristic of a logistic element is that it is somehow unique in the way it positively contributes to the system. This uniqueness should be very obvious because if all of the elements are exactly alike there would be no need for a list of separately defined ILS elements. It is this uniqueness that provides each element the "right" to be listed as a separate logistical element.

A third characteristic of an ILS element is that it should represent something that has always been part of a system. Looking at the specifics of each element, one can see that

each element represents a set of actions that have always been found in a system even before these actions were represented and described by a formal ILS element list. To take a case in point, Manpower and Planning have always been a factor in the procurement of a system. Before the advent of the DoD list of ILS elements, Manpower and Planning were just naturally incorporated into a system's development. The use of a formal listing of ILS elements ensures that all specific actions are incorporated into a system throughout its life cycle. The use of a specific label and definition of this label, now called an ILS element, is just more insurance that the ILS actions are thoroughly researched and incorporated into the life cycle of all systems.

A fourth characteristic of an element, that closely follows that of the last characteristic, is that an element represents a certain level of required system expertise. This level of expertise is required due to the increased complexity of today's systems and the increased complexity in the acquisition of these systems. It is seen, for example, that Support Equipment needs to be just as sophisticated or more so in order to support a future highly complex system. One only has to look at the diagnostic machinery auto mechanics currently use to see that system complexity is on the increase.

A fifth characteristic of an ILS element is that the element adds value to the system. Another way to view this

characteristic is to describe or list, using the customer's perspective, the value a particular element provides or adds to the customer's system. For example, the Training and Training Support ILS element is highly valued by the customer. This element provides the necessary training to the customer so that they can successfully operate and maintain the system. The same is true for the current listings of the other ILS elements. One of the desired outcomes of each element is to satisfy the customer's demands and desires. The only way to accomplish this is to successfully integrate all of the required ILS elements into a system during all phases of its life cycle.

The sixth and probably most important characteristic of a logistic element is given away by the title: "Integrated Logistics Support Elements". An element has to harmoniously and successfully interact with all of the other elements. This interaction or integration is what makes the system work. One interesting way the private sector views this characteristic as a requirement of the DoD required ILS elements (Green, 1991, p.9) is:

> U.S. Military Service regulations on integrated logistics support explain that design influence is an intangible ILS element but significantly affects overall system readiness, supportability, and affordability.

This successful interaction is what also gives the system synergy. Synergy is:

the system's output where the total effect is greater than

> or superior to the effects obtained through the parts functioning independently. (Schoderbek, 1980, p.341)

It is the successful interaction or synergy of the logistic elements that enable a system to properly function throughout its entire life cycle. The following characteristics have been determined by the author to be common requirements in all of the ILS elements that are described above:

1. An element must play an important role throughout system's life cycle;
2. An element must be unique in comparison to the other elements;
3. An element must represent a factor that is inherent to the system;
4. An element must represent a level of expertise;
5. An element must positively contribute to the customer's value of the system; and
6. An element must provide a vital contribution, through integration, to the system's overall synergy.

The above list represents the criteria that should be used by logisticians when they develop a set of ILS elements. The above criteria also provide the clue as to why there is not one standard set of logistic elements used by all acquisition personnel, both in the military and private sector world. The clue is that the use of these criteria is system specific. Each organization's acquisition personnel need to develop a list of logistic elements that best suits their specific system's goals. For the military, these goals are provided by

DoD in the form of instructions and directives.

C. PART TWO

This part of the analysis utilizes the set of criteria developed in the first part to evaluate ETS. This evaluation is used to determine whether Engineering and Technical Services can qualify for inclusion as an Integrated Logistics Support element.

The first ILS element criterion, playing an important role in the system's life cycle, is very much a characteristic of ETS. During the developmental stages of a system, the manufacturer uses information gathered by their field representatives to determine the exact requirements, based on the Mission Needs Statement, that the customer desires of the system. At the manufacturers' plants and facilities, contractor technical representatives provide the initial training to the customer's training personnel who will then be used to train personnel at the system's installed location. In the case of the Navy, the CPS provide this training to DoD personnel, NMTS and/or NCTS. The current policy concerning system acquisitions is for CPS to be provided for a period of one year following the installation of the system at a DoD location. These contractor services are supposed to end once the Navy has accepted complete control of the system, meeting the Initial Operating Capability (IOC) date, and can thus provide organic system support. If contractor services are

required past the one year mark, a waiver for renewal of the contractor support is required. Many factors, that will be discussed later in this thesis, have resulted in the Navy personnel operating these complex systems to need outside technical services and support. It is ETS personnel who are called upon to provide these services to the system operators. This support can take the form of NETS personnel or CETS which are provided through a contract.

In the private sector, during the life cycle of a system, manufacturer representatives and/or specially trained field representatives are called upon by the system's user, the customer, concerning a multitude of tasks. These tasks begin with the manufacturer installing the system at the customer's location and continue with the representatives providing training to the customer's employees. During the life of the system, the customer will contact the manufacturer for support ranging from easy trouble shooting related questions to more complex problems and advice. All of these tasks accomplished by manufacturer representatives amount to what is provided by ETS in the Navy.

The second ILS element criterion, uniqueness, is a characteristic found in the very nature of what ETS represent. Field representatives provide the training and system support that are not accomplished or covered by the other ILS elements. Using the military's list of ten ILS elements, one could conclude that if all of the elements were properly and

effectively incorporated into a system throughout its life cycle, there would be no reason for technical support from outside sources once initial customer organic support has been established. For example, the Training and Training Support element should ensure that the customer can provide its own in-house technical experts. The Maintenance Planning element should be able to provide all of the necessary maintenance support required of a system as it goes through its different life cycle phases and the problems associated with aging.

Unfortunately, no matter how much effort is put into ensuring these elements are completely covered and incorporated in the systems life cycle, there are always problems that crop up in the future that require outside support. These problems are more pronounced in the military due to several factors, the largest of which is that the military usually falls short of its goals when it comes to incorporating all of the ILS elements. This is caused by its use of faulty estimates of "support manpower, parts and equipment" which are either "optimistically stated or understated" by the project managers. (Boynton, 1984, p.31) It is ETS that is able to provide the unique services required in support of DoD systems that the current use of the existing ILS elements has failed to cover. Engineering and Technical Services personnel are able to keep abreast of the latest developments associated with a system and use this knowledge to train the customer's personnel to maintain and support the

system.

The third characteristic, that the ILS element must represent a factor that has always been inherent to the procurement and support of the system, is closely related to the first two characteristic but goes a step further. All of the elements have been used in one sense or another in systems prior to the official decrees that specifically listed them as individual ILS elements. The same can be said of ETS. Any system or component that is supplied by a manufacturer has always had some form of ETS associated with it. This could be something as simple as manufacturer installation teams to formalized training and support for the customer provided by the manufacturer. Most private sector customers, purchase some sort of a maintenance support contract to provide for system support during the life of that system. System support provided by the manufacturer has always been and will continue to be an inherent part of the customer-manufacturer relationship. The extent of this support is highly dependent on the complexity and life span or life cycle costs of the system.

The fourth criterion, a logistical element represents a level of expertise associated with a system, is again an integral part and precisely what is expected of and found in a field or technical representative. Engineering and Technical Services represents a pool of personnel who have a particular background and expertise associated with a system.

This can be system specific or a specific knowledge of a particular component. Hill (1993, p.248) lists what the requirements of a Field Service Representative should be. The entire list is provided in Appendix F. In short, he says a field representative needs to be an expert on all aspects of the system and the rep must also have superior communication and customer relations skills. It is this highly experienced knowledge of the system that the customer seeks from ETS. The customer expects that the manufacturer can provide the professional maintenance and personnel support that today's complex systems frequently require.

The problem the military and in particular the Navy faces concerning military experts is caused by several factors including ever increasing system complexity and the incorporation of new changes. A DRMI study concluded that problems associated with a lack of system experts in the military are due to a number of factors. The most noticeable factor is that of constant personnel rotations within the Navy. A sailor might receive enough in house training, both formal and on-the-job (OJT), to be considered an expert but the tour of duty with that command and hence that system is typically two to four years. Due to the constraints of the Naval personnel system and the sea-shore rotational requirements, that system's expert will more than likely spend the next duty tour or couple of tours of duty away from the operational system environment. This person now loses the

expert abilities through a lack of practice. Engineering and Technical Services are able to provide maintenance and information continuity during the constant rotation of operators. Another problem with the military system is a failure or lack of training to keep the expertise needed by operational personnel at a self sustaining level. (Boynton, 1984, pp.46-47)

The fifth characteristic, positively adding value to the customer's system, is instinctively inherent in the what ETS provides to the customer. The customer buys a system with the intent and knowledge that the manufacturer will be able to provide assistance and guidance in establishing initial and continued support for the system. This support can either be part of the original purchase agreement or it can be obtained through a separate contract. In the case of Naval Aviation acquisitions, initial support is part of the original contract and is followed on by additional contracts. The customer relies upon the assurance that upon the IOC, ETS can be called upon to provide system support, assistance, and training throughout the remainder of the system's life cycle. The effective implementation and continued support of the system depends on the support that is provided by ETS. The contact that the operators experience in the field, while working with technical representatives, will greatly affect the military's perception and assurance that the system will receive adequate support during its operational life. This

assurance is necessary to help foster and support good manufacturer/military relations and dealings.

A logistic element provides a vital contribution to the overall synergy of a system. This sixth criterion of an ILS element is perhaps the most important. The whole concept of ILS is to create an environment for the successful integration of the listed elements to provide total life cycle support of the system. By harmoniously working together, all of the elements combine to make and support the system. Each element by itself contributes to the support of the system but alone it cannot make the system whole. The major role ETS plays in the synergy of the system is that of providing a communications feedback link between the system operators and the system's creators and managers.

It is the field representative who can provide the best informed and most critical information to the manufacturer or contractor pertaining to the status of a system that is in operation at the customer's location. It is this vital communication link that contributes to the system's synergy. When a customer is experiencing a problem with the operation of a system, the manufacturer's field representative is the most qualified person to communicate all of the particulars of the problem back to the manufacturer's engineers. Engineering and Technical Services personnel make up this valuable communications link in the military. Whenever a problem or modification to a system is encountered, ETS personnel are

summoned. If the problem is beyond the ETS personnel's scope then they get into direct contact with the manufacturer. This system link between the manufacturer and the system support personnel allows for more accurate and quicker trouble-shooting of the problem at less cost. The ETS person is able to effectively translate the problem as experienced by the operator into terms that the manufacturer's engineers can understand. This will give the engineers a more precise picture of the problem with less wasted time and effort expended due to miscommunications which are usually seen in dealings between operators and engineers.

D. SUMMARY

There is no single standardized listing of ILS elements that is correct to use in all situations. It is also true that there is no one definition of what determines an element's eligibility for consideration for being a member of an ILS list. Because of the above mentioned facts, the first part of this analysis develops six criteria that represent the characteristics required of an ILS element. Each of these criteria is recognized as being found in common with all of the various listings of ILS elements available in both the military and private sector acquisition systems. It is imperative that an element possess all six of these criteria. Of the six criteria, the most important are that the element be:

- Important throughout the system's entire life cycle,
- Uniquely different from the other elements being considered, and
- An integral part of the systems overall synergy.

It is these three criteria working in conjunction with the other three criteria that enable a logistician to define and recognize a logistic element for inclusion in their list of ILS elements. This list of ILS elements needs to be specifically developed and tailored to meet the requirements of the customer. In the military, this is accomplished by DoD so that there will be standardization in the military acquisition system.

The second part of this analysis uses the criteria developed to analyze whether or not Engineering and Technical Services meets the requirements of an element for consideration as an ILS element. The supporting examples and dialog indicate that ETS does in fact represent a logistic element and can be considered a stand-alone ILS element.

V. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

The analysis developed in this thesis is derived through the examination of data obtained through various civilian and military sources that delve into the subject of ILS and ETS related fields. This chapter states the researcher's conclusions based on the above findings. Recommendations for the use of ETS as an ILS element and the possible future of ETS is also discussed.

B. CONCLUSIONS

Engineering and Technical Services are a necessary and very real element of all systems. Some form of ETS has been used to provide system support since the beginning of the manufacturer/customer relationship. Engineering and Technical Services play a critical role in a system's life cycle from initial installation and training to continued and upgraded support. When ETS are being procured it must be remembered that, according to previous research done by Marsh (1989, p.10) the customer is

> ...buying a level of effort from a contractor. With these services the Government is buying expertise, knowledge, and time...

One of the most important aspects associated with ETS is that they add to the synergy of the system. ETS provides a very

valuable communication link between the manufacturer's engineers and the customer. The communication aspect of ETS is even more important because ETS provide not only valuable communication between the contractor and the field activities but they also provide valuable information to the field operator's command structure. This in turn provides for the quick dissemination of system related information to all other operational users of that system. In the military that information could be very minor such as an easier way to accomplish a particular procedure or something very important such as changing a procedure that will prevent a possible failure thus saving a valuable resource.

Engineering and Technical Services meet the criteria that are developed in the last chapter. In summary, ETS:

1. Play a very important role throughout a systems life cycle, from birth to grave;
2. Provide an unique service to a system that is not included in other elements;
3. Provide services which have always been and continue to be an inherent part of a system;
4. Represent a level of expertise that is not provided for by the other elements or by the customer;
5. Is a value added component to a customer's system;
6. Thoroughly integrates with the other ILS elements, adding to the overall synergy of the system.

1. Answer To The Primary Question

Yes, it makes good logistical sense to add ETS as a separate element of ILS. This would give the military eleven ILS elements to consider when acquiring a new weapons system through the military acquisition process. The current list of ten ILS elements used by the military provides a majority of the life cycle support required of a system. Today's acquisition and systems managers effectively incorporate the current ten elements into a system. The fact is that no matter how effectively they utilize the current ten elements, there is still always a need for ETS by the operators in the field. Military acquisition personnel still have not perfected the use of the current ten ILS elements. This thesis mentions that large uncertainty and inaccuracies in forecasting twenty-year life cycle costs, manpower requirements and availability, and future modifications, exist. These uncertainties and inaccuracies eventually lead to problems in system maintenance and support. The operators then have to rely on ETS to overcome these problems. The elimination of technical services appears not be a choice. The incorporation of ETS as a separate ILS element is justified so that ETS can be incorporated. as accurately as possible, into a system's life cycle cost.

2. Answers To The Subsidiary Questions

Engineering and Technical Services are known in the military and private sector by a multitude of terms that have been used throughout this thesis, some of which are found in Appendix A. The best definition of ETS is that it is a pool of personnel who possess an expert knowledge of the components that make up a particular system. This knowledge includes the engineering know how and communications skills necessary to be able to work effectively with the system's engineers at the manufacturer's facility and to provide various services such as training and support for the customer. These services are provided throughout the system's life cycle. Initial support is usually provided for by the initial system acquisition contract. Follow on support, usually associated with the ever increasing complexity of the system in support of modifications, are provided through the use of ETS. This can vary from support provided through a contracted source or by an organization that has a pool of ETS personnel such as the Navy's NAESU.

The analysis done in this thesis shows that ETS does meet the criteria established of an ILS element. There are those in the private sector (Hill, 1993) who concur that Field Services do represent an integral part of today's systems and should therefore be a separate element of ILS. It is the author's opinion, developed from the feedback received during the interview process, that there would be some dissenting

personnel in the military acquisition field who think that the current list of ten ILS elements is sufficient. These same personnel feel that if these ten elements are correctly incorporated into a system's acquisition then the system will be adequately supported throughout its life cycle. However, there are currently no weapons systems in use that do not have some level of ETS associated with them. Fortunately there are also personnel in the military who realize that there is a need for ETS as an eleventh ILS element. This group of personnel is represented by the Joint Engineering and Technical Services (JETS). Joint Engineering and Technical Services is a group made up of ETS managers representing each of the armed services plus a representative from the Aerospace Industries Association (AIA). They are currently working on better ways to standardize and utilize ETS in all of the military branches. It must be recognized by all of the services and contractors that in these severe fiscally constrained times, all personnel associated with weapon systems procurement need to be speaking the same language and complementing each others' procedures. Each service currently has its own ETS system. Although they all fall under DoD guidance, there are still enough differences that each service can learn from each other. A unified front needs to be exhibited by all of the services in order to maintain a viable DoD ETS program.

The major benefit of incorporating ETS as an ILS element is that ETS could now be considered an integral part of a system's life cycle and would therefore be part of the system's life cycle cost analysis. These two factors would legitimize and ensure adequate funding for the support that ETS currently provide to the system operators.

C. RECOMMENDATIONS

The following recommendations are made by the author based on the information described in the previous chapters. These recommendations are in support of making system acquisitions more realistic and cost effective.

1. **It is recommended that Engineering and Technical Services be added to the current list of ILS elements that are used by DoD as an eleventh element.**

The military and the private sector have to come to the conclusion that Engineering and Technical Services are an important element in the lifetime support of a system. The key to successful ILS support is to effectively integrate all ILS elements. That means that ETS can no longer be an after thought that will get taken care of and considered after the purchase of a system. Engineering and Technical Services need to be incorporated from the very beginning of a system's development. By making ETS an ILS element, system acquisition managers will have to ensure that ETS are considered and implemented at every stage in a system's life cycle. This in

turn will ensure that ETS is part of the life cycle cost analysis. The results of this analysis will add support and credence to the request to fund ETS related services and activities.

2. **It is recommended that greater emphasis placed on the procedures used to develop an ILS element list. The criterion developed in Chapter IV can be used as a starting point in choosing ILS elements.**

The text books and instructions dealing with ILS elements do not provide enough detail as to how and why the elements were chosen. It seems obvious that the elements are used to support the system throughout its life cycle but there is no specific mention of what criteria should be used when choosing the elements to make up an ILS element list. It is also not mentioned that there is no one universal listing on ILS elements that is to be used by all acquisition personnel. The military does standardize their ILS elements through the use of a Department of Defense Directive. All logistic students need to know at the beginning of their logistic education that each activity needs to tailor their ILS element list to their specific type of system. The only prerequisite is to ensure that the elements that are chosen meet the provided criteria developed earlier.

3. **Recommendations for further research**

Many possibilities exist concerning the use of ETS in the future. New advancements in technology are constantly

creating better systems but along with these systems comes more complexity. The military and private sector will have to rely more and more on ETS to keep up with this increased complexity. Another factor is that due to fiscal constraints, the useful life of current systems will be increased. This increase will undoubtedly uncover more difficult maintenance problems that will be faced by the operators. This will result in the operators requiring the assistance of a system expert or the manufacturer's engineers. This assistance is facilitated and accomplished by ETS.

The military is currently exploring new ways to augment ETS. Three of these new developments are:

- Expert Systems Program or "Tech Rep On A Floppy"
- Interactive Electronic Tech Manuals (IETM)
- Wearable Computer system.

A short description of each can be found in the Appendix H. These systems are currently in the experimental or development phases but may yield some good topics for future research into the field of ETS. The emphasis that these systems are working under is that they are being developed as enhancements and not replacements for ETS personnel. There has been and continues to be a very welcomed and documented need for ETS and the services they can provide to the customer in support of a system.

APPENDIX A: ABBREVIATIONS AND ACRONYMS

AIA	Aerospace Industries Association
CETS	Contractor Engineering Technical Services
CFS	Contractor Field Services
CMS	Contract Maintenance Services
CPS	Contractor Plant Services
DoD	Department of Defense
DRMI	Defense Resources Management Institute
ETS	Engineering and Technical Services
FIELD REPS	Field Representatives
IETM	Interactive Electronic Tech Manual
ILS	Integrated Logistics Support
IOC	Initial Operating Capability
JETS	Joint Engineering Technical Services
LSA	Logistics Support Analysis
LSAR	Logistics Support Analysis Record
LSP	Logistics Support Plan
MNS	Mission Need Statement
NAESU	Naval Aviation Engineering Service Unit
NCTS	Navy Civilian Technical Specialists
NETS	Navy Engineering Technical Services
NMTS	Navy Military Technical Specialists
ORD	Operational Requirements Document
TECH REPS	Technical Representatives

APPENDIX B: BLANCHARD ILS ELEMENTS

The following is a list and brief description of the eight major elements of logistic support found in the fourth edition of LOGISTICS ENGINEERING AND MANAGEMENT: (Blanchard, 1992, pp. 11-13)

1. Maintenance Planning. This includes all planning and analysis associated throughout the systems life cycle. It is also used to integrate the other areas associated with system support.

2. Supply Support. This includes all materials needed to support the system. It also includes all provisioning and logistical considerations.

3. Test and Support Equipment. This includes all peculiar and common test and support equipment required to ensure the proper functioning of the system.

4. Packaging, Handling, Storage, and Transportation. "This category basically covers the initial distribution of products and the transportation of personnel and materials for maintenance purposes."

5. Personnel and Training. This includes all formal, initial and replenishment training required to operate and maintain the system.

6. Facilities. Includes all special facilities required to operate and maintain the system.

7. Data. This includes all data required to operate and maintain the system and the data required by all of the other elements in order for them to be implemented effectively.

8. Computer Resources. Includes all computer equipment and the materials required to support the computers. "The resources to support computer-aided acquisition and logistic support (CALS) requirements are also included."

APPENDIX C: GREEN ILS ELEMENTS

The following is a list of ILS elements listed in LOGISTICS ENGINEERING (Green, 1991, pp.12-19):

1. Maintenance Planning
2. Manpower and Personnel
3. Supply Support
4. Support and Test Equipment
5. Training and Training Devices
6. Technical Data
7. Computer Resources Support
8. Facilities
9. Transportation
10. Packaging, Handling, and Storage
11. Standardization and Interoperability

APPENDIX D: JONES ILS ELEMENTS

The following is a list of ILS elements found in the LOGISTIC SUPPORT ANALYSIS HANDBOOK (Jones, 1989, pp.4-10):

1. Maintenance Planning
2. Manpower and Personnel
3. Supply Support
4. Support and Test equipment
5. Training and Training Devices
6. Technical Documentation
7. Computer Resources
8. Packaging, Handling, Storage, and Transportability
9. Facilities
10. Reliability and Maintainability

APPENDIX E: HILL ILS ELEMENTS

The following is a proposed listing of ILS elements found in PRODUCT SUPPORT SERVICES AND TRAINING (Hill, 1993, p. 4):

1. Personnel
2. Training
3. Training Systems
4. Product Service
5. Technical Data
6. Maintenance Activities
7. Supply Support
8. Support Equipment
9. Warranties

APPENDIX F: FSR QUALIFICATIONS

The following represents the minimum qualifications proposed by Hill (1993, p. 249) for field service representatives:

1. Basic education and experience in an engineering discipline with a minimum education equaling 4 years in any one or a combination of the following:

   a. Accredited college education in an associated field of interest

   b. Service school or trade education in the associated field of interest

   c. On-the-job education through full time employment with duties that are basically in the associated field of interest

2. Demonstrate excellence in verbal and written communications with equal clarity with peers, engineering staff, and customer personnel

3. Knowledge or trainable in the fielded subsystems and support equipment, sufficient to enable rapid fault isolation and repair of those subsystems and support equipment to ensure optimum utilization of the delivered product

4. Capable of developing a basic understanding of the overall customer product, its performance characteristics, and its various subsystems and their relationships

5. Ability to work independently, without continuous technical guidance, in the performance of all assigned tasks

6. Ability to conduct classroom and informal on-the-job training to both operations and maintenance personnel

7. Willing to be on call to assist customer personnel on a 24-hour-per-day basis

8. Ability to conduct failure investigation and analysis and assist with incident and accident investigations as required

9. Capable of understanding and working within the constraints of the customer's operations, maintenance, and supply environment

10. Ability to work with modification, retrofit, and service teams and coordinate their activities

APPENDIX G: JETS

This brief description of Joint Engineering Technical Services (JETS) is based on information contained in a 03 February 1994 FAX sent to DRMI from NAESU Headquarters. The purpose of JETS is to

> provide guidance and recommendations on policy, procedures, requirements, procurement, and deployment of engineering and technical services throughout the Department of Defense.

The first formal meeting of Navy, Army and Air Force ETS managers was on August 1993. This meeting established JETS. In October 1993, AIA became a member of JETS. A November 1993 JETS meeting resulted in the development of a proposed JETS charter and the draft of DoD directive 1130.2. This directive used to be dated 26 January 1983 and had been previously cancelled. The new directive's title is: Management and Control of Engineering and Technical Services. The basis of this new directive is to "foster consistency across" all DoD components. It is the goal of JETS to have ETS recognized as a logistic element and to have a consistent policy throughout DoD concerning ETS and their use.

APPENDIX H: NEW DEVELOPMENTS

This is a brief description of three systems that are under development by the Navy to be used as tools to support Engineering and Technical Services. These systems are:

1. Tech Rep on a Floppy (Jacobs, 1994)
2. Wearable Computer (Barnett, 1994)
3. Interactive Electronic Technical Manuals (Barnett, 1994)

It is stressed that these are to be used in conjunction with ETS not as a replacement for ETS.

NAVSEACENLANT/PAC has developed a system called: A Tech Rep on a Floppy Disk (TROF). This is an expert system computer program that provides the non-expert user a highly interactive user friendly mechanism for obtaining expert advise and decision-making capabilities normally requiring an expert. The system is currently deployed and undergoing shipboard evaluation. It is intended to be used as a tool by fleet operators to trouble-shoot and maintain systems without having to rely on tech reps from shore. Tech reps are used to develop the floppy disks which are then used by the fleet. The disks provide enough information for fleet operators to service and maintain their systems without having to have a tech rep actually present whenever the operator encounters a problem. The floppy will provide a logical sequence of

procedures which are used to trouble-shoot the problem. Technical assistance is available if the problem cannot be solved using TROF. Current indications are that TROF has an inverse relationship between the number of technical assist calls made versus a TROF for a system. Simply stated, the number of technical assistance requests for a system has gone down for each system that has incorporated a TROF program.

Another system being evaluated by Naval Sea Systems Command, Indian Head Division, Naval Surface Warfare Center (NSWC) is the Wearable Computer. This is a system where the technician working on a system wears a computer and a headset with a visor. The visor contains a display of the information needed by the technician. It would allow the technician to interact with the system to determine its status. This info would then be used by the technician in conjunction with an expert based system like TROF to perform maintenance on the system. The whole setup would be voice activated allowing for hands free operation.

The third system is also being evaluated by NSWC and is called: Interactive Electronic Technical Manuals (IETMs). This system is broken down into the five classes listed below:

1. Page-Image Systems
2. Page-Oriented Hypertext
3. Linear Structured IETMs
4. Hierarchically Structured IETMs

5. Integrated Process IETMs

The Class One system is basically digitized pages and are cumbersome to use. The current CD ROM manuals are an example of this system. The next two classes are improvements over the Class One but are still difficult to use. The Class Four system puts all information into a data base system so that data retrieval is much quicker. The Class Five system is the goal of the IETM project. It incorporates an expert system in a user friendly format.

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